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UCRL-TR-233410

Results of LLNL investigation of NYCT data sets

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UCRL-TR-233410

Lawrence Livermore National Laboratory

August 3, 2007

Greg Slovik
DNDO

Greg:

Upon examination we have concluded that none of the alarms indicate the presence of a real threat.

A brief history and results from our examination of the NYCT ASP occupancy data sets dated from 2007-05-14 19:11:07 to 2007-06-20 15:46:15 are presented in this letter report.

When the ASP data collection campaign at NYCT was completed, rather than being shut down, the Canberra ASP annunciator box was unplugged leaving the data acquisition system running. By the time it was discovered that the ASP was still acquiring data about 15,000 occupancies had been recorded. Among these were about 500 alarms (classified by the ASP analysis system as either Threat Alarms or Suspect Alarms). At your request, these alarms have been investigated. Our conclusion is that none of the alarm data sets indicate the presence of a real threat (within statistics).

The data sets (ICD1 and ICD2 files with concurrent JPEG pictures) were delivered to LLNL on a removable hard drive labeled FOUO. The contents of the data disk amounted to 53.39 GB of data requiring over two days for the standard LLNL virus checking software to scan before work could really get started. Our first step was to walk through the directory structure of the disk and create a database of occupancies. For each occupancy, the database was populated with the occupancy date and time, occupancy number, file path to the ICD1 data and the alarm ("No Alarm", "Suspect Alarm" or "Threat Alarm") from the ICD2 file along with some other incidental data.

In an attempt to get a global understanding of what was going on, we investigated the occupancy information. The occupancy date/time and alarm type were binned into one-hour counts. These data are shown in Figures 1 and 2.

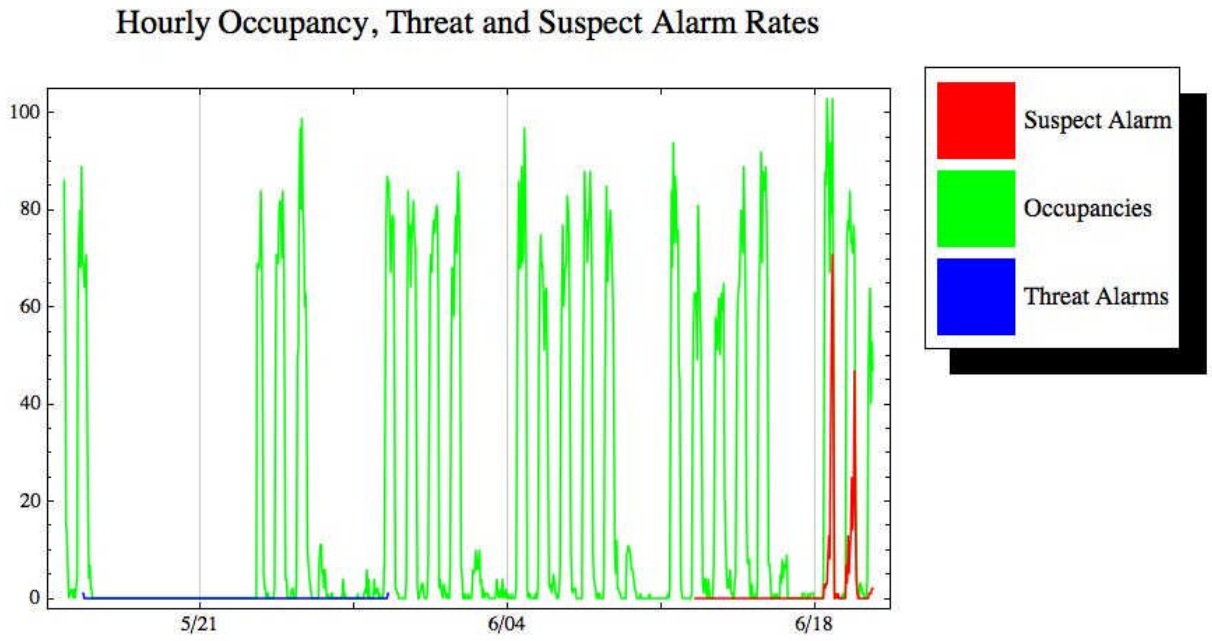

Figure 1. History of hourly occupancy, threat alarm and suspect alarm rates for the entire data set.

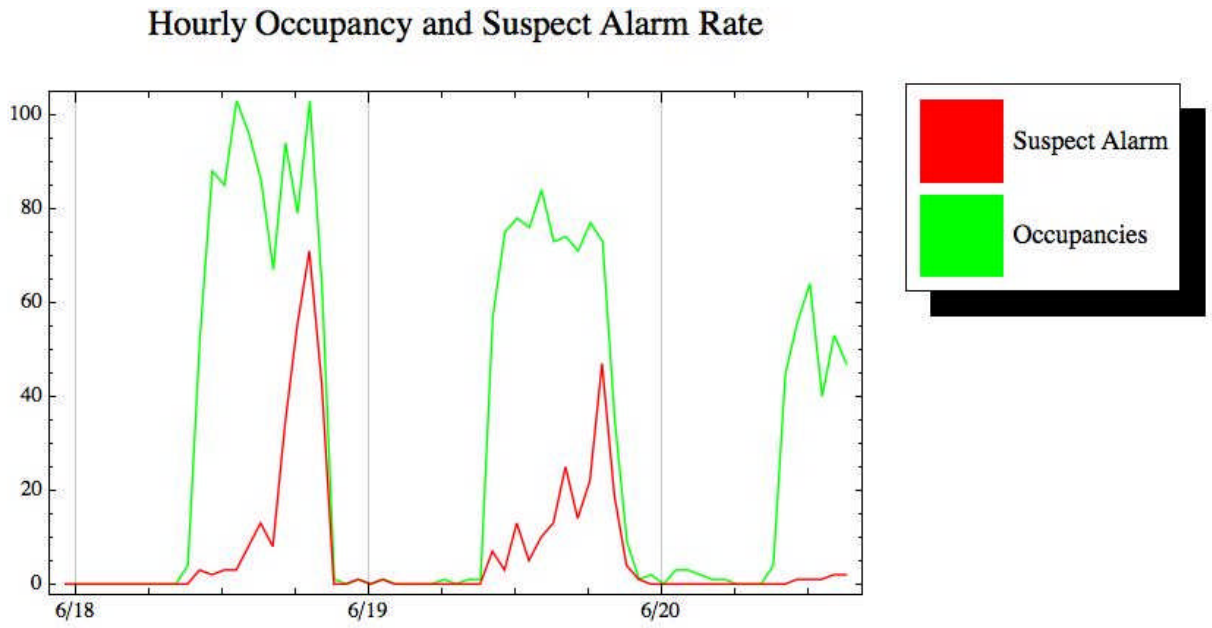

Figure 2. History of hourly occupancy and suspect alarm rates for the last few days of the data set.

It is worth noting that June 17 and the days around it were extremely hot weather and that environmental control is crucial to the performance of detector systems. A record of the temperature data collected at the JFK weather station is shown in Figure 3.

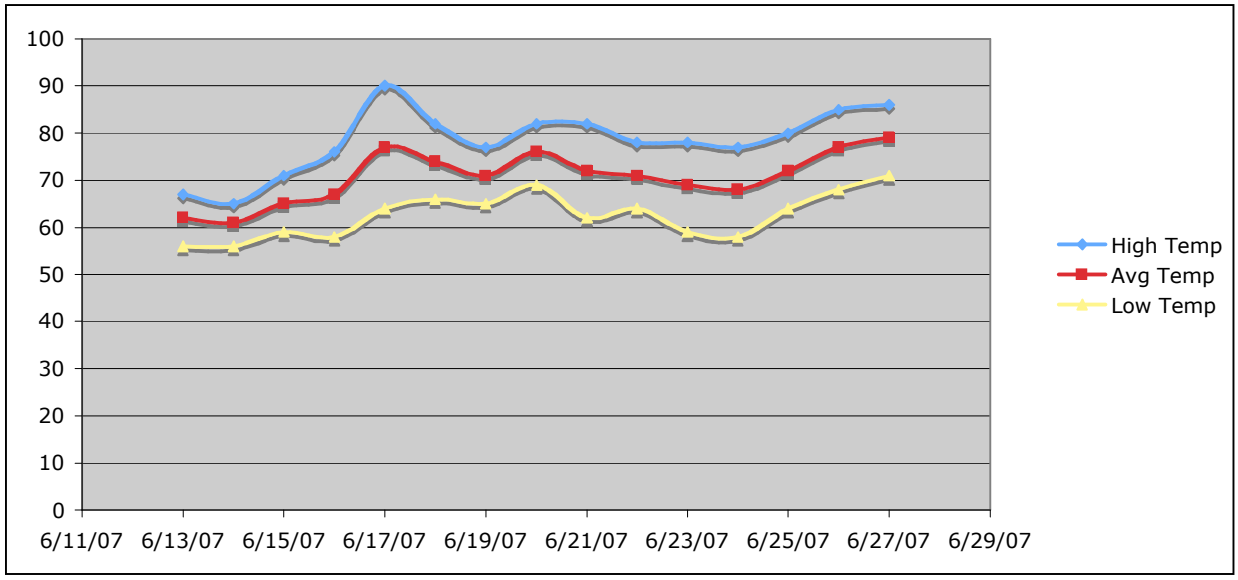

Figure 3. Temperature record for part of the data collection period (data for JFK weather recording station).

From the raw alarm rate data it was inferred that the rash of suspect alarms, which occurred during the hottest parts of the last few days of the data collection period, were almost certainly due to temperature related detector system malfunction(s). Our guess is that the detectors had been operating without any maintenance or other attention for the several weeks of the data collection period (e.g. no air filter changes etc.). Anybody familiar with the operation of HPGe detectors and the associated electronics and computers would not be surprised at some sort of temperature-driven failure under these circumstances.

In the data set there were three occupancies that generated Threat Alarms. These are summarized in Table 1.

Table 1. Summary of Threat Alarms

Timestamp	On-site identification	Detector type	Review conclusion
2007-05-15 16:07:34	No nuclide analysis	Neutron	Measured count not significantly above background rate => statistical fluctuation: no real threat
2007-05-15 16:43:13	No nuclide analysis	Neutron	Clearly an artifact (likely due to electronic noise/breakdown)
2007-05-29 13:10:30	U235/SNM	Gamma	False Alarm, characteristic lines not present

Both of the Threat Alarms on May 15 were neutron-only alarms. The Alarm on May 29 was gamma rays only with SNM/^{235}U identified. Note that the occupancy that generated the alarm on May 29 has a background spectrum that is time-stamped 1986-04-30T15:30:00

Threat Alarm: 2007-05-15 16:07:34
This alarm was based on neutron gross counting. The neutron count rate history, aggregated from all detectors, is shown in Figure 4.

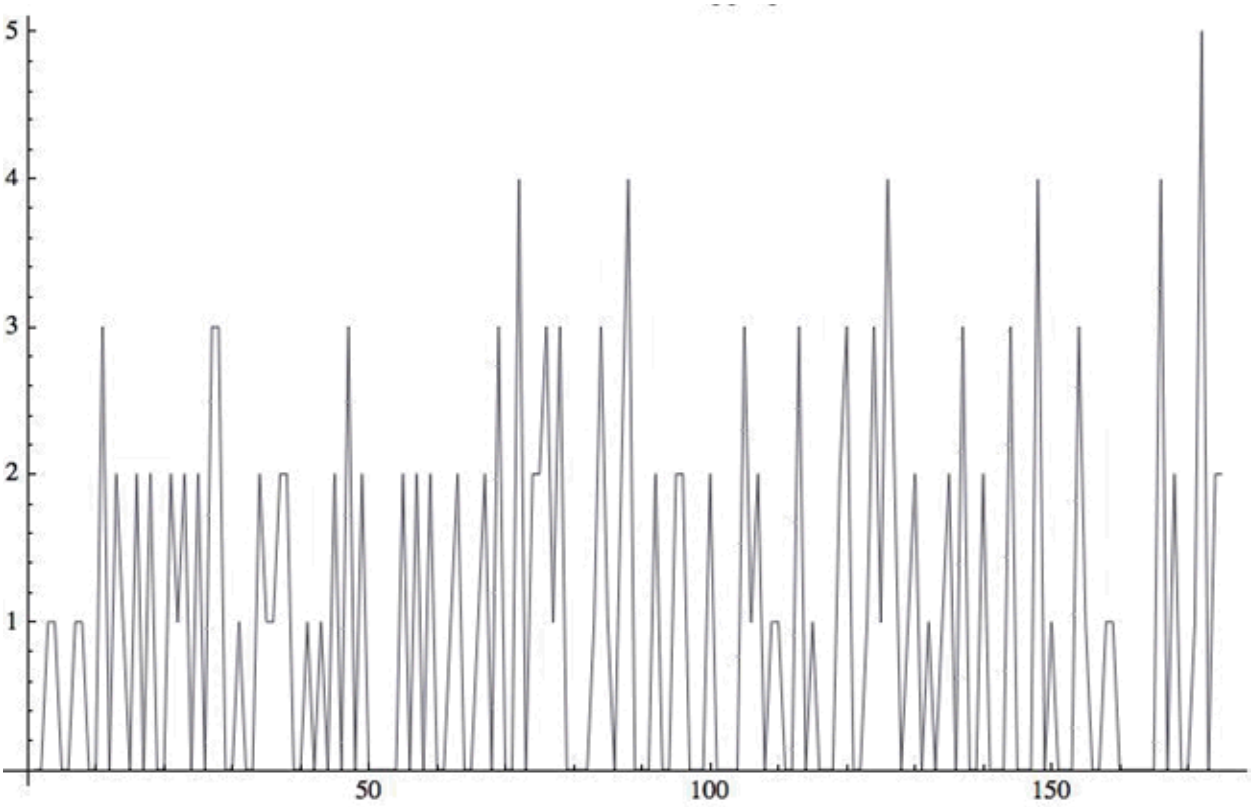

Figure 4. Neutron Count rate aggregated over all neutron detectors occupancy at timestamp 2007-05-15 16:07:34

The average neutron counts in a time interval is 0.937143 with a variance of 1.40407. Note that if the data were described by a Poisson distribution the variance should be equal to the mean, therefore, the measured data exhibit more variability than would be expected from a simple random source. The background mean counts from the ICD2 file for this occupancy[i] is 0.843472. The average of the measured data exceeds the expected value by only about 8%. The conclusion is that this alarm was caused by a statistical fluctuation.

Threat Alarm: 2007-05-15 16:43:13
This alarm was based on neutron gross counting. The alarm was based on two time slices (aggregated over the eight detectors) with hundreds of counts. In both of these time slices all of the counts came from detector Da2N while all the other detectors recorded zero counts. The only plausible explanation is an electronic noise event in that detector. No real source of neutrons could produce such an event.

[i] From the ICD2 elements
<Canberra:BackgroundCountRate>7.7117406872735508</Canberra:BackgroundCountRate>
and
<Canberra:BackgroundCollectionTime>0.109</Canberra:BackgroundCollectionTime>

Threat Alarm 2007-5-29 13:10:30
This alarm was based on detection of ^{235}U in the summed spectrum from all the detectors. The summed spectrum is shown in Figure 5. The characteristic spectral lines from ^{235}U do not show up (within statistics) in these spectra leading to the conclusion that this alarm was a false alarm possibly caused by a statistical fluctuation.

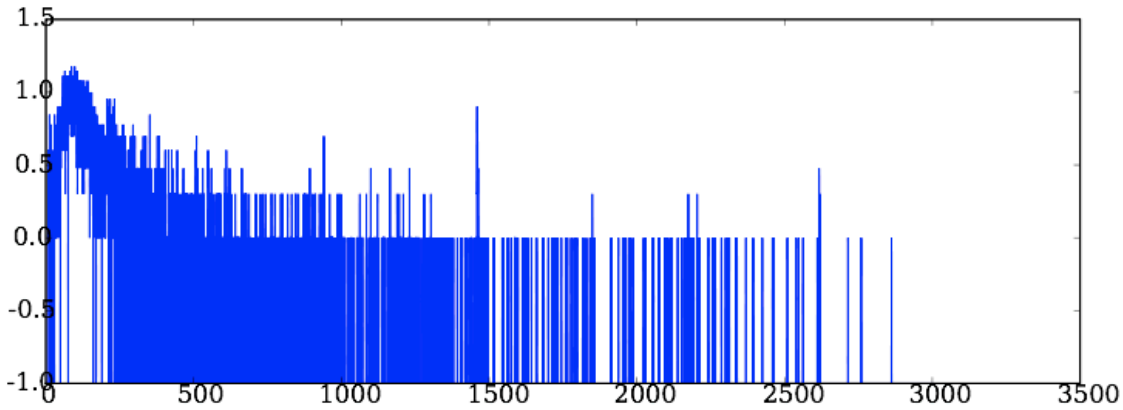

Figure 5. Gamma ray spectrum from Threat Alarm 2007-5-29 (log counts vs. keV, full energy range).

Suspect Alarms

For all of the Suspect Alarms (with only three exceptions) the ICD2 files indicate that the system was operating with reduced capability and the nuclide was identified as ^{241}Am.

The three exceptional Suspect Alarms (other than Confidence="Reduced Capability" and Nuclide="AM241" are summarized in Table 2.

Table 2. Summary of non-"Reduced Capability" Suspect Alarms

Date	Occupancy Number	On-site identification	Confidence	Review conclusion
2007-06-12 13:08:44	155	AM241	Low	Mis-identification based on malfunctioning detector.
2007-06-18 12:50:22	199	CF252	Low	No neutron counts detected. Mis-identification based on malfunctioning detector.
2007-06-18 19:47:18	821	H_NCAP	Low	No neutron counts detected. Mis-identification based on malfunctioning detector.

A survey of the Suspect Alarm data sets for the last three days of the data collection clearly show that four of the eight detectors were malfunctioning, in at least two different ways. Two (randomly chosen) one-second time slices from an occupancy on 2007-06-18 are shown in Figures 6 and 7 with the sum of all the time slices in Figure 8.

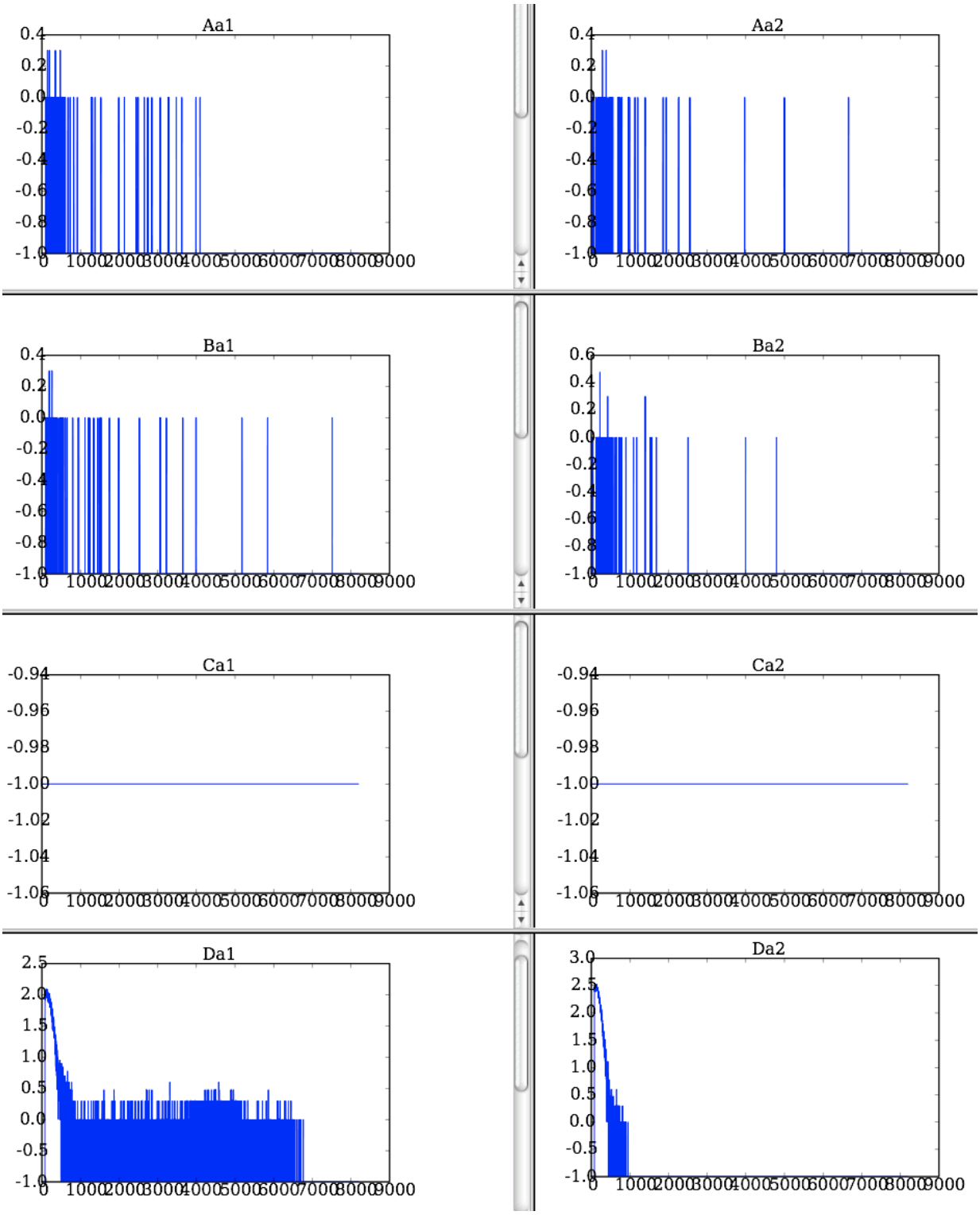

Figure 6. Spectra (log of counts vs. channel number) from each of the eight detectors (one second time

slice).

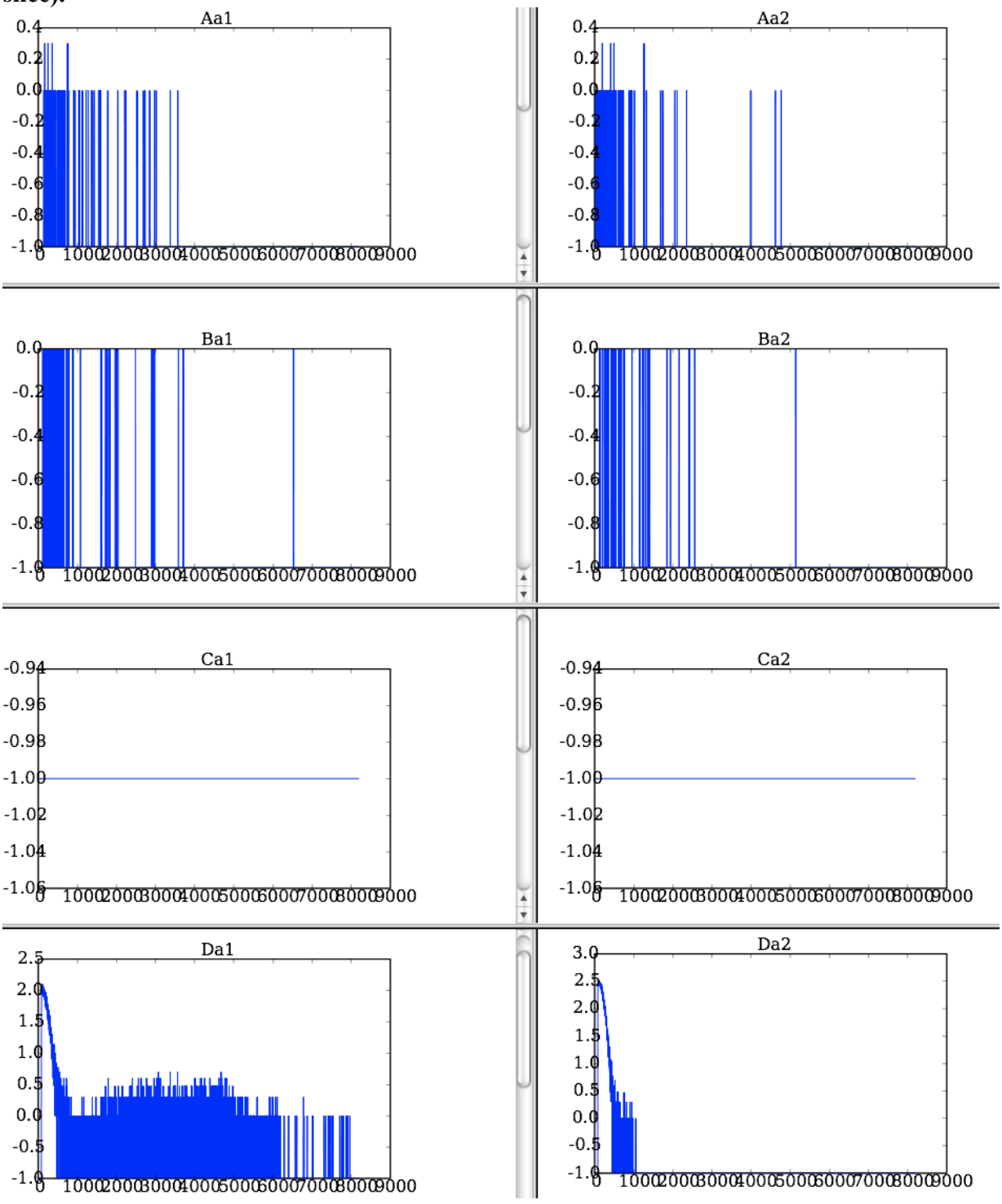

Figure 7 Spectra (log of counts vs. channel number) from each of the eight detectors (a different one second time slice).

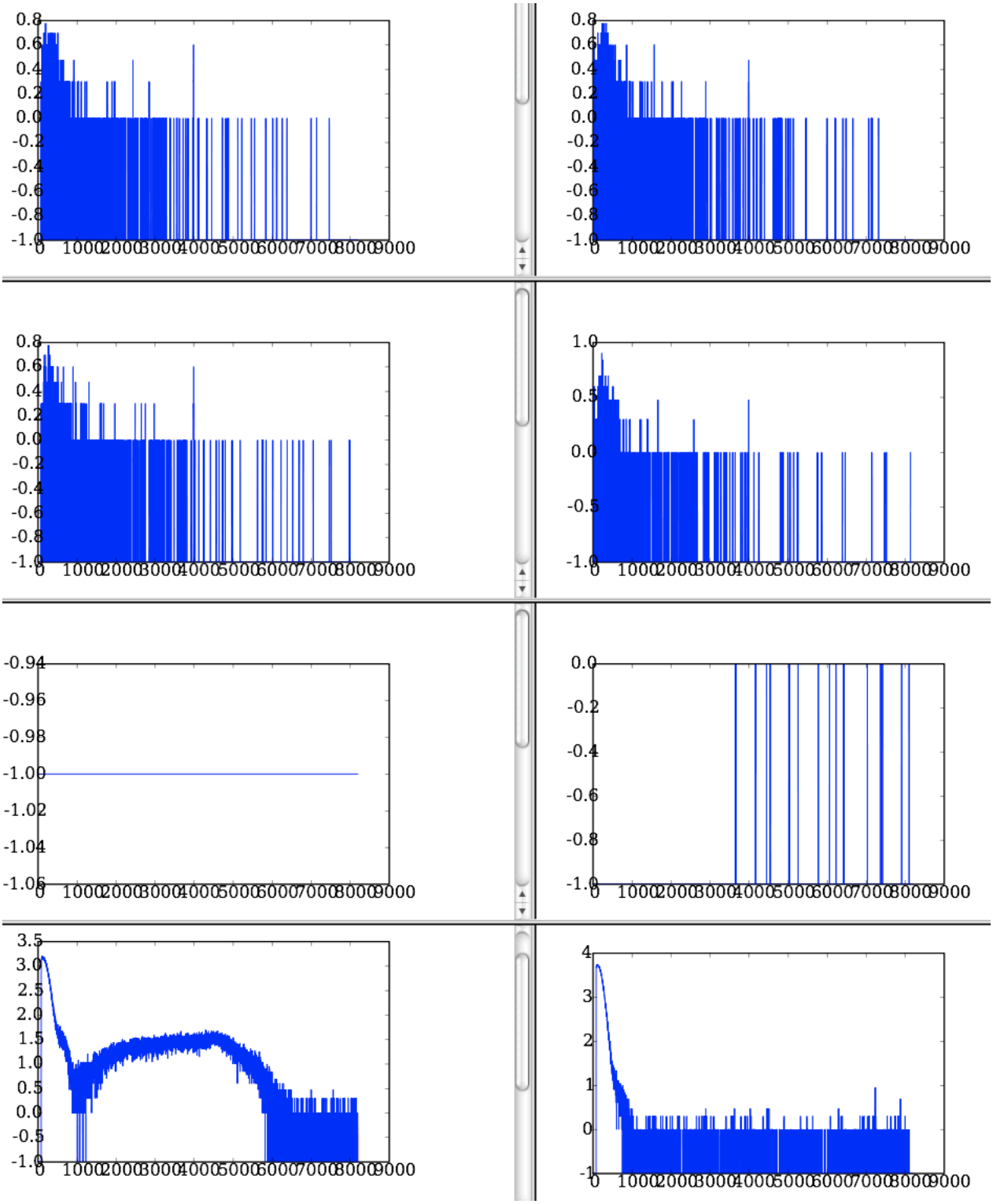

Figure 8. Spectra (log of counts vs. channel number) from each of the eight detectors (summed over all time slices of the occupancy).

Detectors Aa1, Aa2, Ba1 and Ba2 seem to be working as expected. Based on the data from only those detectors there should be no alarm. Detector Ca1 seems to be completely dead, producing no pulses at all. Detector Ca2 is clearly also malfunctioning. There are several plausible explanations for detectors behaving as Ca1 and Ca2 were, e.g. high voltage being turned off, power supply failures etc.

The spectrum shapes and total count rates from detectors Da1 and Da2 indicate a system that has extremely high noise. Some noise source is being filtered through the shaping amplifier and driving the ADC to sense and digitize nonsense as fast as it can run. The rapidly falling feature at low channel numbers in Da1 and Da2 are classic artifacts of noise spectra. For all of the alarms from 6/18 on the data are very similar; all show detectors Ca1 and Ca2 essentially dead and detectors Da1 an Da2 producing huge amounts of noise. Since the signature of ^{241}Am is a line at very low energy almost all of the spectra analyzed were interpreted as reflecting ^{241}Am when the real source of the counts was noise.

A couple of observations are in order:

- The background spectra in the ICD1 files never seemed to reflect what was going on with the malfunctioning detectors. Background data that are from another time or place are really no help.
- Algorithms should detect and reject data from grossly malfunctioning detectors.

There are several lessons one could learn from the exercise summarized here:

- HPGe detector systems need a reasonably well-controlled environment in order to produce good data
- State-of-health information on detectors (e.g. bias current, temperature) and the environment (temperature inside the instrument housing etc.) could be used to avoid incorporating bad data into threat identification algorithms

If you have any questions or any clarification is needed please get in touch with me.

Kenneth E. Sale
Physicist
RN-Division